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SEED PRIMING EFFECT ON PHYSIOLOGICAL TRAITS OF KODO MILLET AND BARNYARD MILLET

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ABSTRACT

Seed priming could advance germination, improve the initial quality characters, improve field emergence, better establishment, crop stand and increase yields in many diverse environments. The present study was undertaken to examine the effectiveness of priming in enhancing the physiological seed quality parameters of kodo millet cv. CO 3 and barnyard millet cv. CO (KV) 2. The seeds were primed with water, KH_2PO_4 2% and Pseudomonas fluorescens 20 % and evaluated for their physiological quality. The nonprimed seed formed the control. Pseudomonas fluorescens 20 % for 6 h was found to improve the speed of germination, germination, shoot and root length, dry matter production, vigour index and seed metabolic efficiency.

KEYWORDS: Priming, Kodo millet, Barnyard millet, Physiological seed quality

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Original Article

INTRODUCTION

Small millets comprise a group of cereal species that are genetically diverse and adapted to a range of marginal growing conditions. Millets are small-seeded grasses that are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture. Even though these millets are having wide adaptability and potential for higher yields, these are mostly grown only in hilly, marginal and sub marginal conditions of soil fertility and moisture where major cereals fail to realize produce satisfactory.

In the last two decades, seed priming, an effective seed invigouration method, has become a common seed treatment to increase the rate and uniformity of emergence and crop establishment. Seed priming is widely recommended pre sowing seed treatment, proven for its invigourative effect. Seed priming is a technique for enhancing the seed quality and improving the overall germination and seed storage in a wide range of crop species (McDonald, 2000). Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance (Bradford, 1986; Taylor and Harman, 1990; Ghassemi-Golezani *et al.*, 2008a, b). Priming allows seed hydration to initiate the early events of germination, but not permit radicle emergence, followed by drying to initial moisture (McDonald, 2000; Ashraf and Foolad, 2005). There are reports that seed priming permits early DNA replication, increase RNA and Protein synthesis, enhances embryo growth, repairs deteriorated seed parts and reduces leakage of metabolites (McDonald, 2000).

Srinivasan (2012) revealed that maize hybrid COH (M) 5 bioprimed with 10 per cent *P. fluorescens* + 20 per cent humic acid with the soaking duration of 8h improved seed and seedling quality characters than unprimed and hydroprimed seeds. Punithavathi (2012) concluded that seed priming with *Azophos* 1.0 %, *Pseudomonas fluorescens* 1.0 % could be recommended as suitable priming treatments for enhancing germination and vigour of TNAU Rice, TRY 1 and I.W. Ponni.

In this context, an attempt was made to study the influence of seed priming on kodo millet and barnyard millet.

MATERIALS AND METHODS

Genetically pure seeds of kodo millet cv. CO 3 (*Paspalum scrobiculatum* L.) and barnyard millet cv. CO (KV) 2 (E*chinochloa frumentacea* Link.) obtained from the Department of Millets, Tamil Nadu Agricultural University, Coimbatore formed the base material for the present investigation. The foxtail millet, little millet and proso millet seeds were primed in water, KH_2PO_4 2 % and *Pseudomonas fluorescens* 20 % with the seed to solution ratio (w/v) of 1:1 for 6 h under ambient conditions (28-30^{0}C). After soaking for specified duration, seeds were removed from the solutions and shade dried at room temperature to bring back to original moisture content. The non primed seeds were used as control. The control and treated seeds were evaluated for following physiological seed quality parameters.

Speed of Germination

Four replicates of twenty five seeds in each of the treatments and crops were germinated in petriplates adopting the top of the paper method as per ISTA (2007). The seeds showing radicle protrusion were counted daily from the date of sowing upto the completion of cumulative germination. Based on the number of seeds germinated in percentage on each of the day, the speed of germination was calculated using the following formula and the results were expressed as number (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots + \frac{X_n - X_{n-1}}{Y_n}$$

X_1: Percentage of seeds germinated at first count

X_2: Percentage of seeds germinated at second count

X_n: Percentage of seeds germinated on n^{th} day

Y_1: Number of days from sowing to first count

Y_2: Number of days from sowing to second count

Y_n: Number of days from sowing to n^{th} count

Germination

The germination test was carried out in roll towel medium using 4 x 100 seeds (ISTA, 2007) in a germination room maintained at 25 ± 2°C temperature and 95 ± 3 % RH. After the germination period of 10 days for kodo and barnyard millet the seedlings were evaluated as normal seedling, abnormal seedling, hard seed and dead seed. Based on normal seedlings, the germination was calculated adopting the following formula and the mean expressed as percentage.

$$\text{Germination (\%)} = \frac{\text{Number of Normal Seedlings}}{\text{Total Number of Seeds Sown}} \times 100$$

Root Length

At the time of germination count, ten normal seedlings were selected at random from each of the crops and used for measuring the root length of seedlings. Root length was measured from the collar region to the tip of primary root. The mean values were calculated and expressed in centimetre.

Shoot Length

The seedlings used for measuring root length were also used for measuring shoot length. The shoot length was measured from the collar region to the tip of the primary leaves and the mean values were expressed in centimetre.

Dry Matter Production

Ten normal seedlings were selected randomly from each of the crops and dried in shade for 24 h and were kept in an oven maintained at 85^0C for 24 h. After the drying period, the seedlings were cooled in closed desiccator for 30 minutes and were weighed in a top pan balance and the mean expressed as g seedlings^{-10} (Gupta, 1993).

Vigour Index

Vigour index (VI) was calculated using the method suggested by Abdul–Baki and Anderson (1973) and expressed in whole number.

VI = Germination (%) x [Root length (cm) + Shoot length (cm)].

Endosperm and Embryo Degradation (Seed Metabolic Efficiency)

Seed Metabolic Efficiency (SME) may be defined as the amount of shoot and root drymatter (g) produced from 1 unit (g) of dry seed weight that was respired. Thus higher the value of Seed Metabolic Efficiency, the higher is the efficiency of seed as more seed reserves would be used for producing roots and shoots. Amount of seed respired (SMR) was calculated as below,

SMR = SDW-(SHW+RTW+RSW)

Where,

SDW - Seed dry weight before germination

SHW - Shoot dry weight

RTW - Root dry weight

RSW - Remaining seed dry weight

Seed Metabolic Efficiency (SME) was calculated using the following formula (Rao and Sinha, 1993).

$$SME = \frac{SHW + RTW}{SMR}$$

Table 1: Influence of Seed Priming on Physiological Seed Quality Traits in Kodo Millet cv. CO 3

Treatments	Speed of Germination	Germination (%)	Root Length (cm)	Shoot Length (cm)	DMP (G Seedlings^{-10})	Vigour Index	Seed Metabolic Efficiency
T_0 - Control	10.21	80 (63.44)	9.78	5.78	0.045	1245	0.763
T_1 - Hydropriming	10.52	82 (64.90)	10.45	6.33	0.049	1376	1.137
T_2 - Seed priming with KH_2PO_4 2 %	10.97	83 (65.65)	10.88	6.76	0.050	1499	1.250
T_3 - Seed priming with *P. fluorescens* 20 %	11.23	86 (68.03)	11.21	7.18	0.052	1582	1.362
Mean	10.73	83 (65.65)	10.58	6.51	0.049	1425	1.128
SEd	0.0761	0.4403	0.0745	0.0464	0.0004	10.1646	0.0083
CD (P= 0.05)	0.1613	0.9334	0.1580	0.0983	0.0007	21.5484	0.0176

Values in parenthesis are arcsine transformed values

Table 2: Influence of Seed Priming on Physiological Seed Quality Traits in Barnyard Millet cv. CO (KV) 2

Treatments	Speed of Germination	Germination (%)	Root Length (cm)	Shoot Length (cm)	DMP (G Seedlings^{-10})	Vigour Index	Seed Metabolic Efficiency
T_0 - Control	17.53	81 (64.15)	11.45	7.10	0.018	1503	0.507
T_1 - Hydropriming	18.50	83 (65.65)	11.79	7.43	0.020	1595	0.821
T_2 - Seed priming with KH_2PO_4 2 %	18.83	86 (68.03)	12.87	7.80	0.023	1778	1.113
T_3 - Seed priming with *P. fluorescens* 20 %	20.66	88 (69.73)	13.20	8.12	0.025	1876	1.137
Mean	18.88	84 (66.42)	12.32	7.61	0.021	1688	0.894
SEd	0.1318	0.4823	0.0878	0.0538	0.0002	12.0183	0.0069
CD (P= 0.05)	0.2793	1.0225	0.1861	0.1140	0.0003	25.4780	0.0147

Values in parenthesis are arcsine transformed values

RESULTS AND DISCUSSIONS

In kodo and barnyard millet, statistically significant variation was observed for speed of germination, germination, root and shoot length, dry matter production, vigour index and seed metabolic efficiency due to priming treatment. The kodo and barnyard millet seeds primed with *Pseudomonas fluorescens* 20 % for 6 h registered higher speed of germination (11.23 and 20.66, respectively) Figure 1 and germination (86 and 88, respectively) than nonprimed seeds (Table 1,2). An increase of 6.9 and 7.9 %, respectively was noticed for germination due to *Pseudomonas fluorescens* priming over nonprimed seeds. *Pseudomonas fluorescens* 20 % bioprimed seeds for 6 h of kodo and barnyard millet measured the longest root (11.21 and 13.20 cm, respectively) and shoot (7.18 and 8.12 cm, respectively). Shortest root

(9.78 and 11.45 cm, respectively) and shoot (5.78 and 7.10 cm, respectively) was observed in nonprimed seed (Table 1, 2 and Figure 1). The kodo and barnyard millet seeds primed with *Pseudomonas fluorescens* 20 % for 6 h produced higher dry matter production (0.052 and 0.025 g seedlings^{-10}, respectively). The dry matter production was lower in nonprimed seed (0.045 and 0.018 g seedlings^{-10}, respectively). The vigour index was higher in kodo and barnyard millet seeds primed with *Pseudomonas fluorescens* 20 % (1582 and 1876, respectively) when compared to other treatments. Figure 1. The vigour index value of control was (1245 and 1503, respectively). *Pseudomonas fluorescens* 20 % primed seeds for 6 h of kodo and barnyard millet also registered more seed metabolic efficiency of (1.362 and 1.137, respectively).

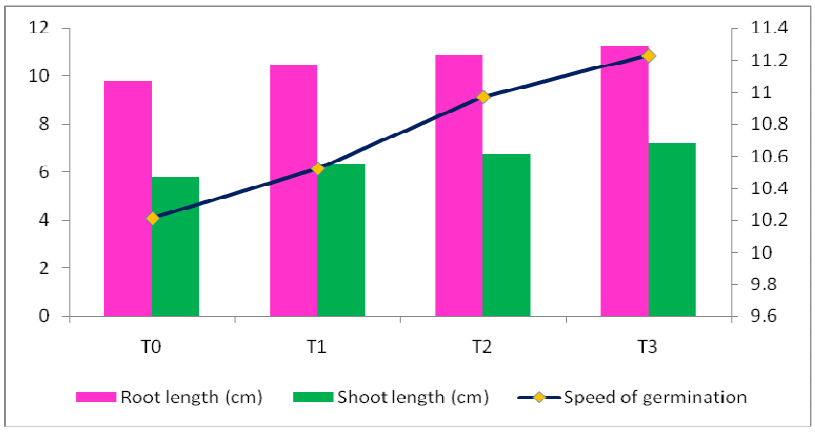

Figure 1: Speed of Germination, Shoot and Root Length of kodo Millet

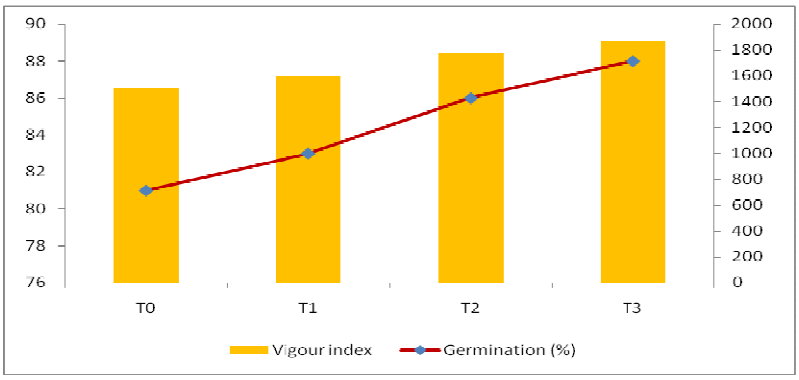

Figure 2: Germination and Vigour Index of Primed Seeds of Barnyard Millet

Early germination in terms of high speed of germination was observed in the present study due to 20 % *Pseudomonas fluorescens* priming for 6 h is in agreement with the findings of Srivastava *et al.* (2010) who reported that in tomato, early germination by 2 - 2.5 days was noticed in the seeds primed with *Pseudomonas fluorescens*.

It is also evident from the present study that seed priming with *Pseudomonas fluorescens* produced desirable results, both promoting the germination as well as increased the seedling growth and vigour of kodo millet and barnyard millet. Similar effectiveness of priming with *Pseudomonas fluorescens* was evident in improvement of seed germination and seedling vigour in pearl millet by Umesha *et al.* (1998); Niranjan Raj *et al.* (2003a); Niranjan Raj *et al.* (2003b); Niranjan Raj *et al.* (2004); in sorghum by Raju *et al.* (1999) and in rice by Praveen Kumar *et al.* (2000; 2001). The enhancement in the seedling growth noticed in this study can be attributed to suppression of deleterious microorganisms and pathogens; production of plant growth regulators such as gibberellins, cytokinins, and indole acetic acid; increased availability of minerals and other ions; and more water uptake (Van Loon *et al.*, 1998; Ramamoorthy *et al.*,

2001).

The results of the present investigation are in agreement with Sunil Kumar *et al.* (2007) who stated that *Pseudomonas* had a positive effect on root development in tomato. Begum *et al.* (2010) reported that in soybean, bioprimed seed with *Pseudomonas aeruginosa* resulted in enhancement of seed germination ranging from 32.4 to 60.7% in two experiments relative to hydroprimed control. Strains of *Pseudomonas fluorescens* appear to be outstanding in this context, because, in addition to induce resistance, they also promote growth and development of plants (Chen *et al.,* 2000; Ongena *et al.,* 2000; Ramamoorthy *et al.,* 2001; Desai *et al.,* 2002; Gnanamanickam *et al.,* 2002).

These enhancements could also be attributed to either direct suppression of deleterious pathogens or indirectly through the production of growth hormones and increases uptake, solubilisation and translocation of less available minerals (Compant *et al.,* 2005).

CONCLUSIONS

Pseudomonas fluorescens 20 % for 6 h was found to be the best treatment for improving the physiological seed quality parameters viz., speed of germination, germination, shoot and root length, dry matter production, vigour index and seed metabolic efficiency of kodo millet and barnyard millet. Seed Enhancement treatments like priming with *Pseudomonas fluorescens* have been considerable and environmentally acceptable alternatives to the existing fungicide seed treatment.

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